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DEVELOPMENT OF A NEW BIO COMPOSITE MATERIAL BY UTILIZING WALNUT SHELL POWDER, COIR AND JUTE FIBER AND EVALUATION OF ITS MECHANICAL PROPERTIES

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ABSTRACT

Increasing concern about global warming has made many researchers focus on the use of natural fibers and minimize the practice of using various non- biodegradable materials to save our valuable soil and environment. The objective of the present study is to investigate and compare the mechanical behavior of coir fiber, jute fiber and walnut shell powder reinforced epoxy -based composites. The mechanical tests have been performed and the comparative analysis has been done on developed composite with different compositions of coir fiber, jute fiber and walnut shell powder with Haksons resins i.e part A & Haksons hardeners i.e part B. Fabrication of tiles was done by using simple hand layout method & the samples were made according to ASTM standards. It has been found that Specimen 1 has maximum flexural, hardness & impact strength.

KEYWORDS: Non-Biodegradable, Walnut Shell Powder, Coir Fiber, Jute Fiber Sisal, Resin & Hand Layout Technique

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INTRODUCTION

Over a past few decades composites, plastics, ceramics have been the dominant engineering materials. A composite is the combination of a matrix and reinforcement, which when combined together gives property that is superior to the property of the individual components.

Natural fiber composites include coir, jute, bagasse, cotton, bamboo, hemp. Natural fibers come from plants. These fibers contain lingo cellulose in nature. Natural fibers are eco-friendly; lightweight, strong, renewable, cheap and biodegradable. The natural fibers can be used to reinforce both thermosetting and thermoplastic matrices. Thermosetting resins such as epoxy, polyester, polyurethane, phenolic are commonly used composites requiring higher performance applications. They provide sufficient mechanical properties in particular stiffness and strength at acceptably low price levels. Recent advances in natural fiber development are genetic engineering. The composites science offer significant opportunities for improved materials from renewable resources with enhanced support for global sustainability. Natural Fiber composites are attractive to industry because of their low density and ecological advantages over conventional composites. These composites are gaining importance due to their non-carcinogenic and biodegradable nature. Natural fiber composites are very cost

effective material especially in building and construction, packaging, automobile and railway coach interiors and storage devices. These composites are potential candidates for replacement of high -cost glass fiber for low load bearing applications. Natural fibers have the advantages of low density and low cost. However, the main disadvantages of natural fiber composite are the relative high moisture absorption. Therefore, chemical treatments are done so as to modify the fiber surface properties.

Composite

A Composite is a superior and unique material which is created by combining two different materials of different physical & chemical properties. It is defined as a combination of matrix & reinforcing materials, which when combined together produces a material with different characteristics from the individual component. Composites consist of one or more discontinuous phases combined in a continuous phase. The discontinuous phase is usually harder and stronger than the continuous phase and is called the reinforcing materials whereas the continuous phase is termed as the matrix.

Table 1: Composition of Some Natural Fibers

Fiber	Cellulose (%)	Lignin %	Diameter (μm)	Hemicellulose %	Elongation %
Coir	37	42	100-450	0.15	47
Banana	64	05	50-250	6-19	3.7
Sisal	70	12	50-200	10-14	5.1
Pineapple	85	12	20-80	16-19	2.8
Jute	71	13	15.9-20.7	13-20	3.0

LITERATURE SURVEY

Pawar and Gaikwad. [1] developed a new hybrid biocomposite material with natural fibers like banana, sisal & wheat straw along with resin & hardener after those mechanical properties such as Flexural, compression and impact strengths of the specimens with different compositions were tested and compared. **Patel *et al.* [2]** studied the ‘‘development of Fly Ash based new composites material as Wood Husk’’ and emphasized that fly ash which is produced from a thermal power plant which is a problematic solid waste from coal combustion can be collected to develop bio-composite material. **Kobayashi *et al.* [3]** investigated the processing and characterization of hemp fiber textile composites with micro-braiding technique and found that the hemp fiber is suitable reinforcement for textile composites. **Ramesh *et al.* [4]** carried out an experiment to evaluate the tensile and flexural properties of hybrid composites and the results are compared. Form the experiment, they found that the incorporation of natural fibers such as sisal/jute with glass fiber improve the tensile and flexural Strength and these composites play a vital role in the field of engineering and technology. They suggested that these hybrid composites can be used for medium strength application.

MATERIALS

- Jute fiber
- Walnut shell powder
- Coir fiber
- Resin
- Hardener

Jute Fiber

In India, China, Bangladesh, Indonesia and Thailand Jute is abundantly produced. This is removed from the woody type of plant, after cutting the tree they are submerged in water for 20 to 30 days then washed in water & dried under the sunlight. Jute fiber is very strong cheap & durable. The fibers are 1 to 4 meters (3-12 feet) long. Jute is comprised mostly of cellulosic fiber partially a textile fiber and partially wood. For this study, jute fiber has been procured from local market of Jhansi.

Walnut Shell Powder

Walnut shells are versatile soft abrasive media with unique physical and chemical properties. These properties make them ideal for a variety of applications, such as walnut shell blasting, tumbling, cleaning, polishing, filtration, non-skid flooring, as well as in soaps and cosmetics. Walnut shells are meticulously crushed and ground to standard mesh sizes that range from abrasive grits to fine powders. The walnut particles residue was widely generated in high proportions in the agro-industry by the grinding of the walnut shell. It is generally light brown to dark brown in color. Walnut shell powder for the present study has been purchased from indiamart.com.

Coir Fiber

Coconut fiber is extracted from the outer shell of a coconut. The common name, scientific name and plant family of coconut fiber is Coir, *Cocos nucifera* and *Arecaceae* (Palm), respectively.Coir or coconut fiber is used in products such as floor mats, doormats, brushes, and mattresses. Coir is the fibrous material found between the hard, internal shell and the outer coat of a coconut. Other uses of brown coir (made from ripe coconut) are in upholstery padding, sacking, and horticulture. White coir, harvested from unripe coconuts, is used for making finer brushes, string, rope and fishing nets. In the present study, coir fiber has been purchased from local market of Jhansi.

Resin

Resin i.e (Haksons part A) used in this study has excellent adhesion to different materials. It has good strength and excellent resistance to chemical attack. It is odorless, tasteless and completely non-toxic. In the present investigation, Haksons resin has been purchased from www.borhiali.com.

Hardener

Hardener acts as a catalyst for resin. In the present work Hardener (Haksons part B) which is used as a mixing ratio of 2:1 means 2 part of resin and 1 part of hardener. Hardener (Haksons part B) has been purchased from www.borhiali.com.

Preparation of Specimen for Mechanical Test

All the specimens are prepared by simple hand layout method in which an open mold is used to fabricate a composite material. The specimens are prepared according to ASTM standard for Flexural, Hardness & Impact tests, respectively. Before lay-up, the mold is prepared with a release agent to ensure that the part will not stick to the mold. Reinforcement fibers can be cut and laid in the mold. It is up to the designer to arrange the type, amount and orientation of fibers being used. A resin must then be catalysed and added to the fibers. A brush or roller can be used to impregnate the fibers with the resin. For our study dimension of the fiber composite tile for specimens is 150 mm x 150 mm respectively.

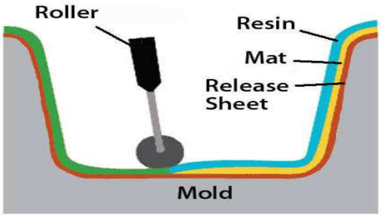


Figure 1: Hand Lay-Up Technique Used for Fabrication

Table 2: Constituents of developed composite tile

Fibres	Walnut Shell Powder	Coir Fibre	Jute Fibre	Epoxy
Quantity for specimen 1	50 gm	15 gm	25 gm	120 ml
Quantity for specimen 2	40 gm	20 gm	20 gm	120 ml

Mechanical Strength Tests

- **Test 1**: Flexural test (3-Point bend test)
- **Test 2**: Rockwell hardness Test
- **Test 3**: Impact strength Test (Izod)

Flexural Test

The three points bending flexural test provides values for the modulus of elasticity in bending, flexural stress, flexural strain and the flexural stress-strain response of the material. The entire specimen for a flexural test was made according to ASTM D790.

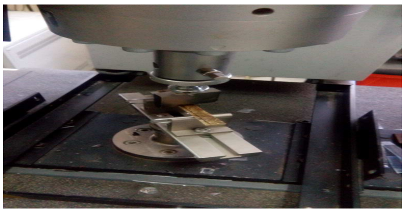


Figure 2: Flexural Test Set Up

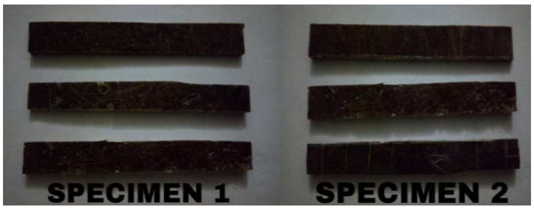


Figure 3: Flexural Test Specimen

Rockwell Hardness Test

The Rockwell scale is a hardness scale based on indentation hardness of a material. The Rockwell test determines the hardness by measuring the depth of penetration of an indenter under a large load compared to the penetration made by a preload. With test method ASTM D 785, on unit R scale. The dimensions of the specimen of Rockwell Hardness test is 50 x 50 mm.



Figure 4: Rockwell Hardness Test



Figure 5: Rockwell Hardness Test Specimen

Izod Impact Test

Izod impact testing is an ASTM standard method of determining the impact resistance of materials. An arm held at a specific height is released. The arm hits the sample. The specimen either breaks or the weight rests on the specimen. From the energy absorbed by the sample, its impact energy is determined. Specimens were made according to ASTM D 256 standard.



Figure 6: Izod Impact Test

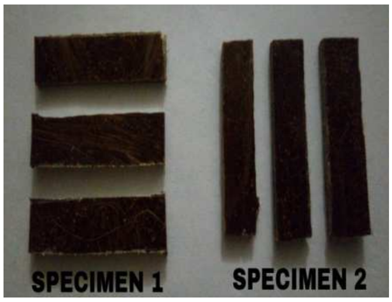


Figure 7: Izod Impact Test Specimen

RESULTS AND DISCUSSIONS

In this section, the evaluation of specimen 1 & 2, which has been fabricated for flexural, hardness and impact are discussed. The mechanical properties of the composite are mainly dependent on many factors such as fiber content, length, and orientation of fibers.

Table 4: Tabular Representation of Flexural Strength of Batch 1 Specimen 1 and 2

S. No	Width (mm)	Thickness (mm)	Support Span (mm)	Speed (mm/min)	Maximum Flexure Load (N)	Flexure Strength @ Max Load (MPa)	Flexure Elongation @ Max Load (%)	Flexure Strength @ Break (MPa)	Flexure Strength @ Break (%)	Flexure Elongation @ Break (%)	Modulus (MPa)
S1, T1	12.70	5.50	88.00	2.00	21.45	7.37	4.95	20.95	7.19	4.99	299.3
S1, T2	12.70	5.50	88.00	2.50	35.23	12.10	3.44	30.13	10.35	4.34	470.1
S1, T3	12.70	5.50	88.00	2.50	9.72	3.34	4.90	8.72	3.00	4.99	128.9
S2, T1	12.70	5.50	88.00	2.50	8.25	2.83	4.87	7.23	2.49	4.99	70.0
S2, T2	12.70	5.50	88.00	2.50	8.71	2.99	4.98	7.94	2.73	4.99	153.9
S2, T3	12.70	5.50	88.00	2.50	14.06	4.83	4.88	12.48	4.26	4.99	142.1

Flexural Test Graph of Specimen 1 and 2

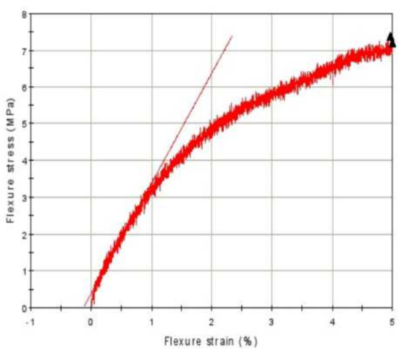


Figure 8: Specimen 1, Test 1

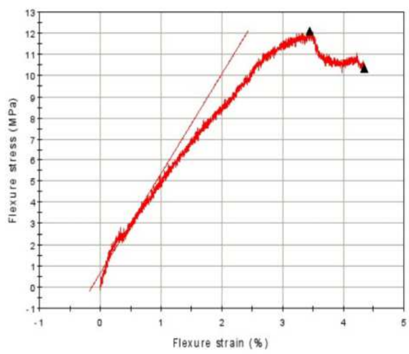


Figure 9: Specimen 1, Test 2

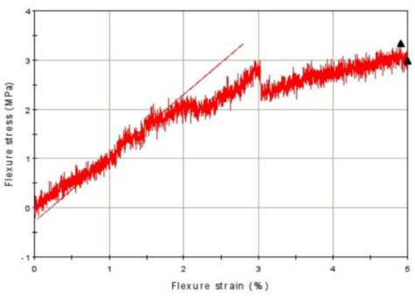


Figure 10: Specimen 1, Test 3

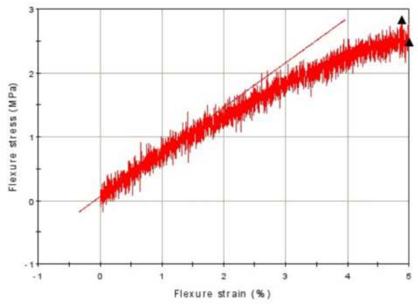


Figure 11: Specimen 2, Test 1

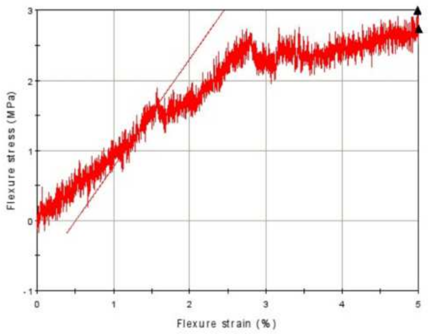


Figure 12: Specimen 2, Test 2

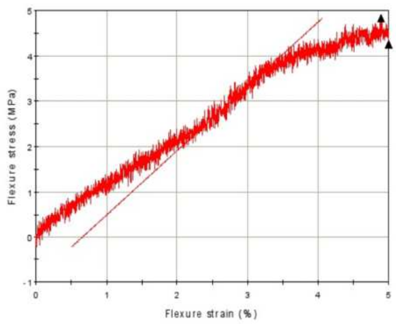


Figure 13: Specimen 2, Test 3

Table 6: Test Results for Flexural, Hardness and Impact Strength

S. No	Name of the Test	Test Method	Unit	Test Value Obtained	
				Specimen 1	Specimen 2
1.	Flexural Strength	ASTM D 790	MPa	7.60	3.55
2.	Hardness	ASTM D 785	R SCALE	72	64
3.	Impact Strength	ASTM D 256	J/m	154.9	94.2

CONCLUSIONS

The jute, walnut shell powder, and coir fiber reinforced epoxy composites are fabricated by hand layup method and compressed using Compression molding machine. The natural fiber composites are subjected to mechanical testing like flexural, hardness and impact test. Depends on the tests results, following conclusions are obtained.

- **The best result of flexural strength obtained is from specimen 1 i.e., 7.60 MPa.**
- **The best result of izod impact strength test is obtained from specimen 1. It has the value of 154.9 J/m.**
- **Specimen 1 of Rockwell hardness test gives the best result i.e., 72 on R Scale.**

On the basis of above evaluation, it was found that specimen 1 has maximum flexural, hardness and impact strength as compared to other specimens for a mechanical test. It can bear higher loads and possess much better strength and can be used as a substitute for various non- biodegradable and wood -based products in future.

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